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STANFORD RESEARCH INSTITUTE
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ANALYSES OF SOIL SAMPLES FROM KIRAM LAND GRANT, JOLO ISLAND, SULU ARCHIPELAGO

Supplement to:

AGRICULTURAL AND ECONOMIC POSSIBILITIES OF OIL PALM CULTIVATION IN THE SULU ARCHIPELAGO

Prepared for:

THE MINDANAO DEVELOPMENT AUTHORITY
MANILA, PHILIPPINES

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SRI Project II-4845

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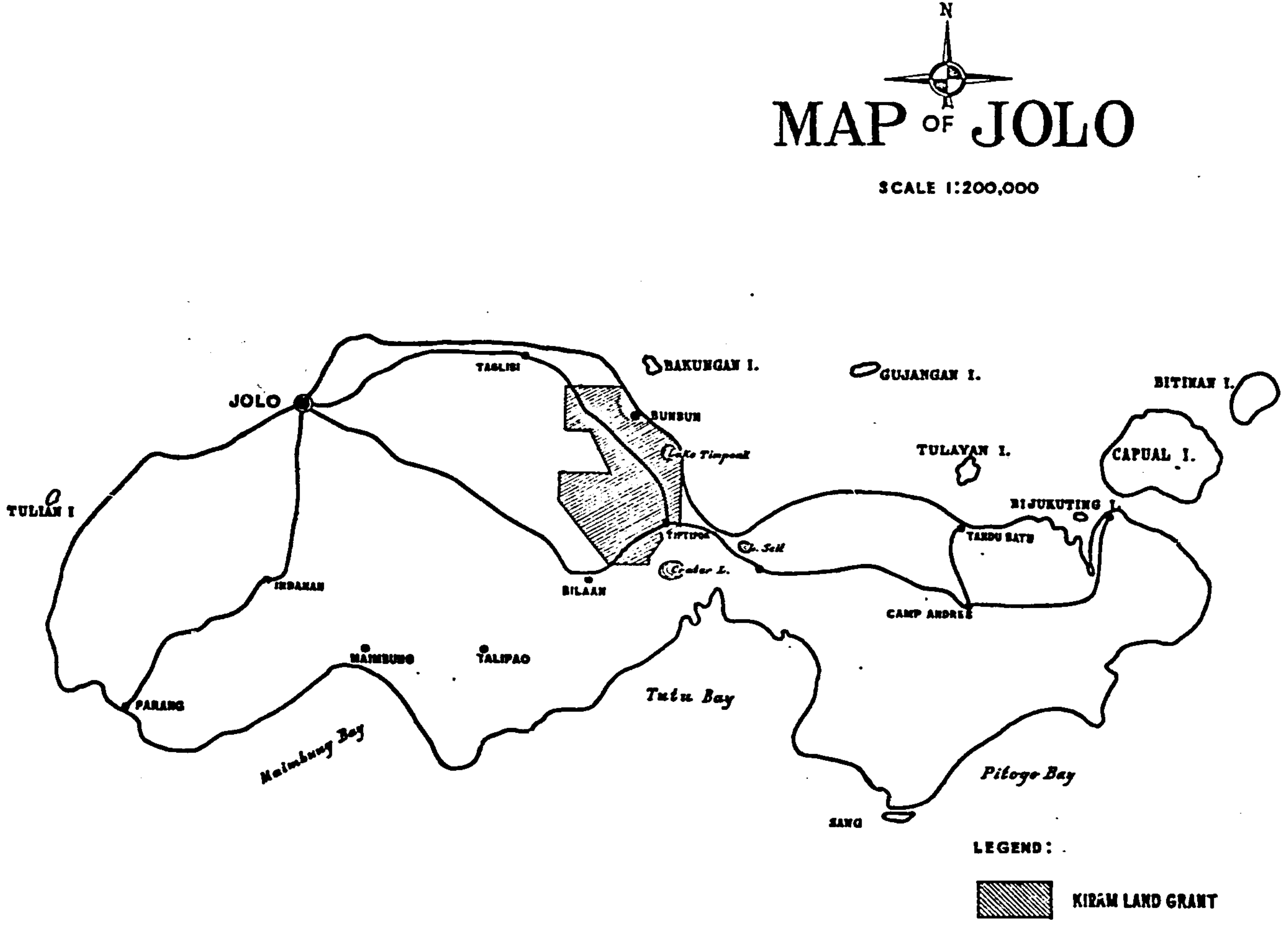
MAP OF JOLO

SCALE 1:200,000



Source: STANFORD RESEARCH INSTITUTE AND MINDANAO DEVELOPMENT AUTHORITY

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I INTRODUCTION

This report is a supplement to the feasibility study Agricultural and Economic Possibilities of Oil Palm Cultivation in the Sulu Archipelago. This feasibility study, hereafter referred to as the basic report, was prepared under contract between the Mindanao Development Authority (MDA) and Stanford Research Institute (SRI). The basic report was made by Ir. Johannes Werkhoven, Department of Agricultural Research, Royal Tropical Institute, Amsterdam. Ir. Werkhoven conducted the study while serving as agricultural consultant under contract with SRI. During his field work on the island of Jolo in October 1964, he collected a limited number of soil samples from the Kiram Land Grant, the area selected for the establishment of the proposed oil palm plantation.

Soil samples also were taken from a farm in the Tandu Batu area to provide additional information for a better utilization of the agricultural lands to advance the economy on the island of Jolo, and to promote a program for proper cultivation methods. All these samples were sent to the Royal Tropical Institute for analysis. While the results of the Tandu Batu soil analysis have no direct bearing on the basic report, they are submitted to provide information of value to the owners so that the lands may be more gainfully utilized. Also, there is the possibility that the land may be used for growing oil palms in connection with the proposed oil palm plantation on the Kiram Land Grant.

II SUMMARY AND CONCLUSIONS

On the basis of the soil analysis made by the Royal Tropical Institute,* and on information gained during Ir. Werkhoven's field observations, it is concluded that the soil fertility on the Kiram Land Grant is more favorable than estimated during the field survey, especially the drainage, and soil content in organic matter and natural potassium. The fertilizer program presented in the basic report for the mature plantation need not be as intensive as assumed. However, the cost figures for fertilizers and production of oil and kernels calculated in the basic report remain valid, as exact fertilizer requirements will have to be determined through foliar analysis and fertilizer experiments. The somewhat more favorable picture of the soil conditions does not justify an increase in the estimated yield; the annual yield of 3.5 tons of oil per hectare is realizable, and under proper cultivation practices might exceed expectations.

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* A. Muller, soil chemist, Royal Tropical Institute.

III ANALYSES OF SOIL SAMPLES FROM THE KIRAM LAND GRANT, JOLO

During the author's study of the possibilities for oil palm cultivation on the Kiram Land Grant on the island of Jolo, a limited number of soil samples were collected at locations distributed over the area. Seven area samples were taken; their locations are shown on the map of the Kiram Land Grant in Appendix A. The soil samples are described in Appendix B. Analyses of the soil samples were undertaken at the Soils Laboratory of the Royal Tropical Institute in Amsterdam; detailed results are shown in Appendix C. An analysis of the soil samples taken from the Tandu Batu area on the island of Jolo is shown in Appendix D. These reports on the investigation of soil samples from the Philippines were made by Mr. A. Muller, soil chemist, Royal Tropical Institute, with additional information provided by the author.

Soil Texture

The texture of the soils collected on the Kiram property is to be considered very uniform. In accordance with the field observations, the soils sampled are of a silty clay loam type, without clear limits as to horizons, and in general gradually increasing in clay content with depth.

The top layer from 0 cm up to 15-30 cm has clay content ranging from 23 to 40 percent; from a depth of about 30 cm downwards the soils are heavy clays.

Soil Composition

Organic matter. The organic matter content as indicated by the percent of carbon (C), is in general still good--in fact, more favorable than the earlier impression obtained during the field reconnaissance. It should be emphasized that since the soils need to be plowed and harrowed several times for cogon control, attempts should be made to avoid a decline in the organic matter status of the soils. In this connection, reference may be made to the Tandu Batu soils (Appendix D), where heavy cropping has resulted in low organic matter content.

The rapid establishment of a leguminous ground cover on the Kiram Land Grant, after the cogon has been controlled, is considered of great importance.

Potassium. The potassium (K) content in the topsoils is high in most cases, with a good reserve available (difference between the two K values shown in Appendix C). In the second layer, however, the K status is much less favorable. The soils of sites I and IV have especially low K contents. However, site IV was already intentionally excluded during the field study from the area of from 1,500 to 2,000 hectares proposed for the oil palm plantation.

Sample I was taken from a slightly sloping field recently planted in abaca; this location already showed more impoverishment of the soil, and measures for maintaining and improving soil fertility should be established.

Nitrogen. In general, the total nitrogen (N) content is excellent. However, intensive cropping and inadequate soil conservation may lead to a serious decline in the N status. This condition is evident in the Tandu Batu soil samples (Appendix D).

Phosphate. The available phosphate content is low or only moderate.

Magnesium and Calcium. Though the soils are already slightly acid, the magnesium (Mg) and calcium (Ca) contents are in general still reasonable, except at site III where both are deficient, and at site VI where the Ca content is low. It may be noted that the land of site III, in the southwest portion of the property, which was covered with cogon, appeared to be less favorable during the field survey and therefore was excluded from the proposed oil palm area of from 1,500 to 2,000 hectares.

Drainage

Despite the heavy subsoils, the low conductivity values indicate a sufficient drainage. This conclusion is in accordance with the information obtained from local sources that the Tiptipon soils drain fairly well. The results confirm the preliminary conclusions mentioned in the basic report that from a physical point of view, the soils in question will provide a large rooting volume and favorable growth conditions for the oil palm, provided that rainfall is adequate.

The field observations suggested that occasional difficulties in drainage might occur because of the silty character of the clayey subsoils. The manganese (Mn) content proved to be rather high, especially in samples 15 and 16 taken from the northern part of the property. This is an indication of poor aeration, and most probably is caused by too compact a soil; this may also be the reason for the poor nitrification which occurs in most of the soils in the Kiram Land Grant.

Although only a limited number of samples were available for investigation, the results obtained are a valuable contribution to the basic report on the potential of the area for oil palms, since the lands of the Kiram Land Grant in general, and the area planned for oil palm in particular, show only slight variations; this fact was observed during the field survey.

Conclusions made on the basis of results of the analyses and the field observations may be summarized as follows:

1. The soils are uniform, deep, and of rather heavy texture, particularly the subsoil; drainage, however, is considered adequate.

2. The organic matter status is still good, but when the land is opened for cultivation, proper measures will be needed to conserve the organic matter.

3. After the establishment of a pure and active leguminous ground cover, N applications to older palms may be reduced; it is to be expected that the adult plantation will need little or no nitrogenous fertilizer.

4. After a few years, the annual application of phosphatic fertilizer may be replaced by biennial or even triennial applications.

5. The natural K supply appears to be favorable, so that there is little need for applications of potassic fertilizers (which are expensive); in the long run, however, higher-yielding palms will require potassic fertilizers under almost all conditions.

6. Available Ca and Mg content is sufficient in the area proposed for oil palm cultivation, but in view of the relatively high Ca content, the uptake of Mg and K may be hampered. There is therefore a need for control through analysis.

The analyses point to a more favorable soil fertility than could have been estimated during the field survey, particularly as regards organic matter, drainage, and potassium content. It is to be expected, therefore, that the fertilizer program for the mature oil palm plantation can be conducted somewhat less intensively than assumed in the basic report. Since, however, the exact fertilizer requirements cannot be forecast and remain to be determined by means of both foliar analysis and fertilizer experiments, there appears to be no need to adjust the cost figures for fertilizing and for production of oil and kernels as calculated in the oil palm feasibility study.

The somewhat more favorable picture of the soil conditions also would not justify raising the yield estimates given in the basic report. The soil analysis confirms that an annual yield of 3.5 tons of oil is realizable from a mature plantation under the conditions existing on the Kiram Land Grant, and suggests that under proper cultural practices, yields from modern high-yielding planting material might exceed expectations.

IV ANALYSES OF SOIL SAMPLES FROM THE TANDU BATU AREA, JOLO

During the survey of Jolo Island, only a short visit could be paid to the Tandu Batu area in the eastern part of the island. The lands available were reported to cover an area of some 800 hectares, which economically is insufficient to support an industry based on oil palm cultivation. The lands visited were flat and partly under cropping (upland rice and cassava). Soil samples were taken from two sites only.

Site VIII, in an old rice plot along the road from Camp Andres to Tandu Batu was covered with weeds, calopogonium, and some cogon. The soil color was brown-blackish in the top layer and turned into greyish in the sublayers. Site IX in the same vicinity (on Vice-Governor Asaah Isnani's land), in a recently harvested rice field, was covered with grasses and weeds. The results of the soil analysis are provided in Appendix D.

Both soils were deep; no water table or parent material was encountered at a sampling depth up to 120 cm. According to the granulometric analysis, the topsoils of both sites are silty clay loams. In the field analysis, the sublayers showed a somewhat less stiff texture than the Kiram soils.

Since the rather heavy Tandu Batu soils are deep and seem to drain fairly well, it is expected that they will provide a favorable rooting volume for the oil palm and assure a good growth of this crop. It should be noted, however, that abaca does not thrive on the flat land in this region. The drainage conditions on the flat heavy soils and in the low-lying parts of the terrain are apparently inadequate for the sensitive rooting system of this crop.

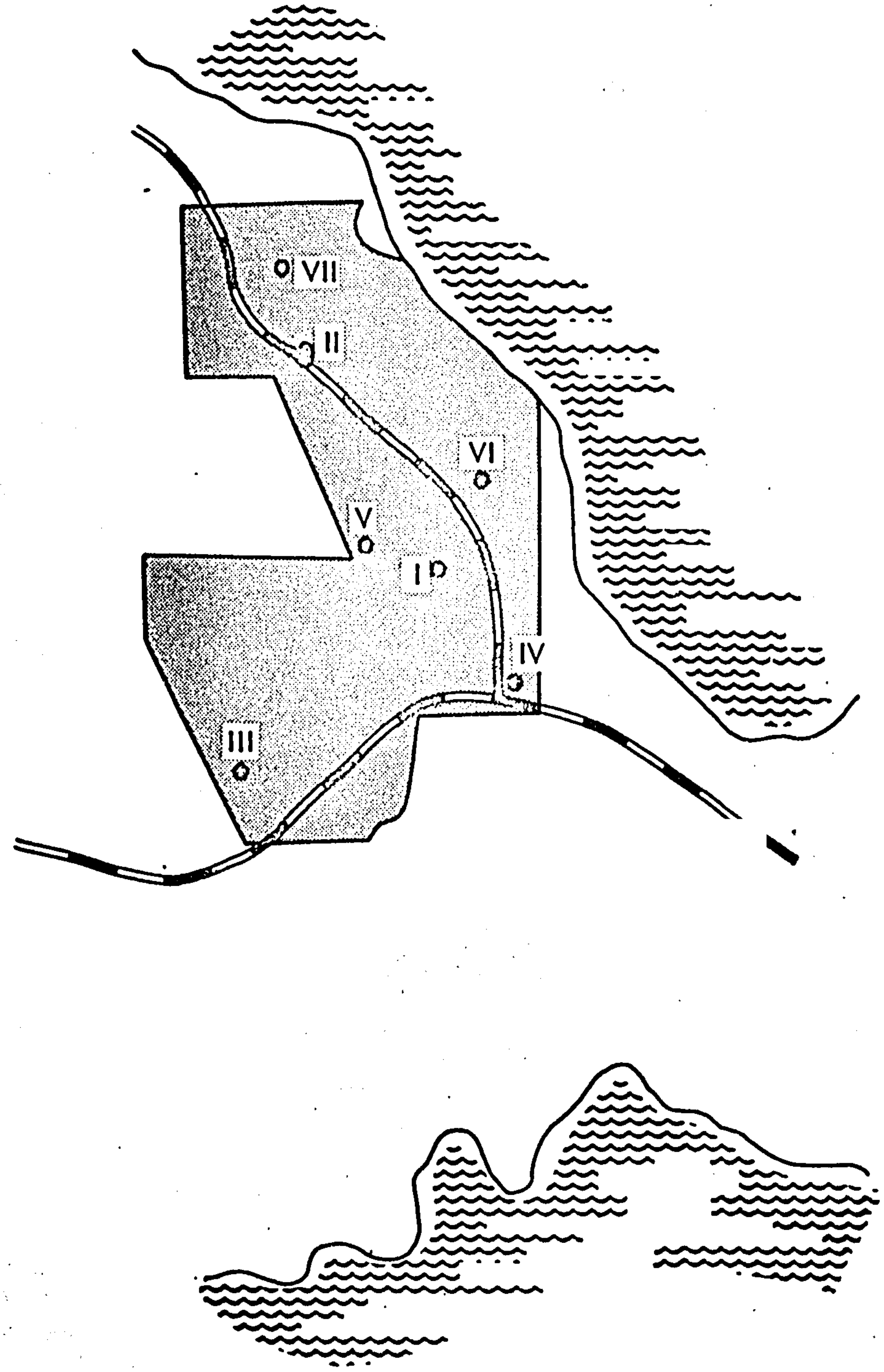
Due to prolonged and intensive cropping, the Tandu Batu soils studied show a much lower organic matter content (only 0.9 percent) and a lower N content than the Kiram soils. The lower total N content is most probably caused by a more favorable nitrification. In this connection, the various analysis results show that nitrification in the top layers of the Tandu Batu samples 3 and 7 is favorable, whereas in the top layers and in the second layers in all of the Kiram Land Grant samples, nitrification is poor and results in rather high ammonium (NH_4) values.

In conclusion, it may be stated that although the Tandu Batu soils studied are more or less poor due to cropping, and full attention should be given to improving their organic matter status, the conditions are considered favorable for the growing of oil palms. In this connection it may be noted that the rainfall is claimed to be somewhat higher than on the Kiram Land Grant; unfortunately, rainfall records are not available

APPENDIXES

APPENDIX A

MAP OF KIRAM LAND GRANT
(Location of Soil Sample Sites)



SOURCE: Stanford Research Institute.

Appendix B

DESCRIPTION OF SOIL SAMPLES COLLECTED ON THE KIRAM LAND GRANT, JOLO ISLAND

Sampling Site	Sample	Date of Sampling	Depth (cm)	Particulars Observed in the Field
I	11	Oct. 5, 1964	0-20	Dark brown clay-loamy top layer changing gradually into more greyish layers of increasingly clayey texture; deep soil on slightly undulating land recently planted with abaca and covered abundantly with weeds; no impervious layers, no parent material, and no groundwater were encountered at sampling depth up to 120 cm.
I	12		20-40	
I	13		40-60	
I	14		60-120	
II	15	Oct. 5, 1964	0-20	About the same soil as samples 11-14, but somewhat reddish, and profile disturbed by plowing; deep soil on rather flat land covered with cogon and planned for the planting of abaca after plowing and harrowing; no hardpan, no groundwater, and no parent rock found up to 120 cm.
II	16		20-40	
II	17		40-60	
II	18		60-120	
III	21	Oct. 13, 1964	0-15	Dark brown clay-loamy top layer changing at a depth of 15 cm into reddish layers; deep soil on flat land covered with sheet cogon; sampling depth up to 90 cm only, due to rain; no groundwater encountered.
III	22		15-30	
III	23		30-60	
III	24		60-90	
IV	25	Oct. 13, 1964	0-18	Blackish clay-loamy top layer, at 18 cm changing into grey-blackish sublayers; slightly sloping land normally used for cropping and scattered with small stones of basaltic origin throughout the soil and on its surface; apart from stones no hardpan and no groundwater found at sampling depth up to 110 cm.
IV	26		18-30	
IV	27		30-110	
V	28	Oct. 13, 1964	0-18	Dark brown clay-loamy top layer followed by more stiff to rather dry underlayers; deep soil covered with heavy cogon ("virgin cogon"), and giving a favorable impression to the touch.
V	29		18-40	
V	30		40-60	
V	31		60-100	
VI	32	Oct. 14, 1964	0-20	Brown blackish clay-loamy top layer changing gra ually into layers of lighter colors; deep soil o flat land formerly used for kaingin farming and covered with grasses and calopogonium; no imperv ous layers, no water table, and no parent rock e countered at sampling depth of up to 220 cm.
VI	33		20-40	
VI	34		40-60	
VI	35		60-120	
VI	36		120-220	
VII	37	Oct. 14, 1964	0-20	Dark brown clay-loamy top soil changing into brownish and stiffer sublayers on a flat land; plowed once for cogon control and to be planted with abaca.
VII	38		20-40	
VII	39		40-60	
VII	40		60-100	

Source: Soils Laboratory of the Royal Tropical Institute, Department of Tropical Products, Amsterdam

Appendix C

Soils Laboratory of the

ROYAL TROPICAL INSTITUTE

Department of Tropical Products

STANDARD ANALYSES C

received from: Stanford Researc

ANNEXE I to letter .... ddo ....

T.P. No.	Sample No.	Origin of sample	Moisture content in % of dry soil	Granulometric analysis: > 2 mm in % of dry soil	Granulometric analysis in % of dry soil < 2 mm: 2 mm — 200 µ	200 — 50 µ	50 — 20 µ	20 — 2 µ	< 2 µ	pH: H$_2$O	pH: KCl	C (Walkley-Black) in % of dry soil	Ca CO$_3$ in % of dry soil	P — Truog in mg P$_2$O$_5$/Kg of dry soil	C
	11	Kiram I 0 - 20	2.7		1	3	27	34	35	5.6	5.0	1.7		50	3
	12	" " 20 - 40	2.9		1	1	12	22	64	5.5	5.3	0.8		22	
	13	" " 40 - 60	2.9		1	1	12	14	72	5.5	5.3				
	14	" " 60 - 120	3.1		1	1	6	14	78	5.2	5.2				
	15	Kiram II 0 - 20	3.3		1	2	45	29	23	5.3	4.8	2.2		10	3
	16	" " 20 - 40	3.3		1	1	8	29	61	5.5	5.1	1.2		26	1.
	17	" " 40 - 60	3.3		1	1	6	21	71	5.6	5.2				
	18	" " 60 - 120	3.3		1	1	4	19	75	5.7	5.4				
	21	Kiram III 0 - 15	3.1		1	2	30	31	36	5.0	4.5	2.2		26	1
	22	" " 15 - 30	3.0		1	2	13	21	64	5.2	4.6	1.3		18	
	23	" " 30 - 60	3.5		1	1	6	17	75	5.7	5.1				
	24	" " 60 - 90	3.2		1	1	5	15	78	5.2	5.3				
	25	Kiram IV 0 - 18	3.1		2	4	25	29	40	5.8	5.1	1.5		26	3.
	26	" " 18 - 30	3.3		2	1	16	25	56	6.0	5.5	0.9		14	3
	27	" " 30 - 110	3.5		1	1	8	16	74	6.1	5.6				
	28	Kiram V 0 - 18	2.9		1	1	37	33	28	5.4	4.9	2.0		18	2
	29	" " 18 - 40	2.8		1	1	13	26	59	5.3	5.0	1.3		4	1.
	30	" " 40 - 60	3.2		1	1	1	17	80	5.4	5.5				
	31	" " 60 - 100	3.1		1	1	5	13	80	5.3	5.3				
	32	Kiram VI 0 - 20	3.1		1	3	25	36	35	5.4	5.0	1.8		32	1
	33	" " 20 - 40	3.1		1	1	8	30	60	5.2	5.1	0.9		4	1
	34	" " 40 - 60	3.5		1	1	10	19	69	5.9	5.3				
	35	" " 60 - 120	3.6		1	1	1	17	80	5.6	5.6				
	36	" " 120 - 220	3.4		1	1	2	19	77	6.1	5.8				
	37	Kiram VII 0 - 20	3.3		1	1	38	37	23	5.5	4.9	1.9		18	2
	38	" " 20 - 40	3.3		1	1	10	23	65	5.7	5.4	0.7		14	
	39	" " 40 - 60	3.4		1	1	8	26	64	5.4	5.1				
	40	" " 60 - 100	3.5		1	1	6	20	72	5.4	5.5				
12															

NALYSES OF SOIL SAMPLES

rd Research Institute

ddo .... to ....

Registered as our Nr A.O. 193

C (Walkley-Black) in % of dry soil	Ca CO$_3$ in % of dry soil	P – Truog in mg P_2O_5/Kg of dry soil	Easily available plantnutrients mg/liter													Supplementary data		
			Extraction with Na-acetate/acetic acid pH = 4.8 Soil/solution = 1 : 2.5, shaking time ½ hour											NH$_4$ acetate in stead of Na-acetate				
			Ca	Mg	K	P	NH$_4$	NO$_3$	Fe	Al	Mn	SO$_4$	Cl	Na	K	Conductivity 1 : 2.5	N	C/N
1.7		50	300	96	25		8	6	0.2	6.8	23	tr	tr	3	42	95	0.16	13.7
0.8		22	85	35	7		4	1.5	tr	16.2	14	tr	tr	8	14	57	0.09	7.9
																27		
																193		
2.2		10	315	156	68		14	6	0.7	11.1	56	tr	tr	4	106	124	0.20	11.2
1.2		26	130	68	40		16	4	0.3	23.6	56	tr	tr	8	60	62	0.13	9.1
																39		
																34		
2.2		26	100	64	33		12	5	1.1	20.4	29	tr	tr	6	58	75	0.20	11.0
1.3		18	10	26	13		12	3	0.3	36.4	30	tr	tr	10	20	49	0.15	8.6
																23		
																18		
.5		26	300	85	17		6	4	0.1	4.3	15	tr	tr	4	38	87	0.16	9.4
.9		14	350	115	8		10	4	0.1	11.7	20	tr	tr	10	16	95	0.12	7.1
																68		
.0		10	255	100	72		12	6	0.4	9.4	34	tr	tr	6	126	103	0.20	10.0
.3		4	145	76	47		10	3	0.2	22.2	31	tr	tr	12	64	71	0.14	9.0
																37		
																23		
.8		32	100	105	79		12	10	0.4	8.7	25	tr	tr	12	158	132	0.19	9.2
.9		4	120	67	35		12	4	0.2	23.2	37	tr	tr	8	52	65	0.12	7.8
																46		
																31		
																36		
9		10	215	105	65		10	4	0.6	27	31	tr	tr	12	112	109	0.19	10.5
7		14	55	27	9		10	2	0.2	20.4	22	tr	tr	6	34	35	0.10	6.8
																53		
																37		

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Appendix D

Soils Laboratory of the
ROYAL TROPICAL INSTITUTE
Department of Tropical Products

STANDARD ANALYSES

received from: Stanford Researc

ANNEXE I to letter .... ddo

T.P. No.	Sample No.	Origin of sample		Moisture content in % of dry soil	Granulometric analysis						pH		C (Walkley-Black) in % of dry soil	Ca CO$_3$ in % of dry soil	P — Truog in mg P$_2$O$_5$/Kg of dry soil
					> 2 mm in % of dry soil	in % of dry soil < 2 mm									
						2 mm — 200 μ	200 — 50 μ	50 — 20 μ	20 — 2 μ	< 2 μ	H$_2$O	KCl			
	3	Tandu Batu VIII	0 - 30	2.9		1	4	24	37	34	5.6	5.2	0.9		36
	4		30 - 60	2.9		1	1	18	23	57	6.0	5.3	0.8		18
	5		60 - 90	3.5		1	1	2	27	69	5.7	5.3			
	6		90 - 120	3.2		1	1	14	14	70	5.7	5.4			
	7	Tandu Batu IX	0 - 30	3.2		1	2	23	38	36	5.7	5.1	0.9		36
	8		30 - 60	3.4		1	1	8	29	61	5.7	5.3	0.4		36
	9		60 - 90	3.6		1	1	11	26	61	5.4	5.3			
	10		90 - 120	3.4		1	1	16	23	59	5.4	5.2			

NALYSES OF SOIL SAMPLES

s Research Institute

ddo .... to ....

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C (Walkley-Black) in % of dry soil	Ca CO$_3$ in % of dry soil	P — Truog in mg P$_2$O$_5$/Kg of dry soil	Easily available plantnutrients mg/liter Extraction with Na-acetate/acetic acid pH = 4.8 Soil/solution = 1 : 2.5, shaking time ½ hour											NH$_4$ acetate in stead of Na-acetate		Supplementary data		
			Ca	Mg	K	P	NH$_4$	NO$_3$	Fe	Al	Mn	SO$_4$	Cl	Na	K	Conductivity 1 : 2.5	N	C/N
0.9	—	36	220	57	30	—	8	10	0.2	4.3	18	tr	tr	16	106	181	0.11	8.2
0.8	—	18	245	59	10	—	8	3	0.2	9.4	19	tr	tr	20	35	104	0.08	10.0
																60		
																57		
0.9	—	36	200	54	47	—	6	9	0.1	4.7	17	tr	tr	12	126	108	0.12	7.4
0.4	—	36	255	94	27	—	8	3	tr	10.4	18	tr	tr	20	46	68	0.09	4.7
																65		
																62		

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